Surgical Infections: An Overview

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INFECTION…..

- Humanity has three great enemies:
  Fever, famine and war,
  Of these by far the greatest,
  By far the most terrible is fever.

William Osler
1849-1919

Outline
- Antimicrobial classification
- Common Pathogens
- Sepsis
- Overview of community acquired infection
- Overview of nosocomial infections
  - SSI

Gram-Positive Aerobes

<table>
<thead>
<tr>
<th>COCCI</th>
<th>BACILLI</th>
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<tbody>
<tr>
<td>clusters - Staphylococci</td>
<td>Bacillus sp.</td>
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<tr>
<td>pairs - S. pneumoniae</td>
<td>Corynebacterium sp.</td>
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<td>chains - group and</td>
<td>Listeria monocytogenes</td>
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<td>viridans streptococci</td>
<td>Nocardia sp.</td>
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<td>pairs and chains -</td>
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<td>Enterococcus sp.</td>
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Gram-Negative Aerobes

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<tbody>
<tr>
<td>Moraxella catarrhalis</td>
<td>E. coli, Enterobacter sp.</td>
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<td>Neisseria gonorrhoeae</td>
<td>Citrobacter, Klebsiella sp.</td>
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<td>Neisseria meningitidis</td>
<td>Proteus sp., Serratia</td>
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<td>Haemophilus influenzae</td>
<td>Salmonella, Shigella</td>
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<td>Actinobacter, Helicobacter</td>
<td>Pseudomonas aeruginosa*</td>
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Anaerobes

- “Above Diaphragm”
  - Peptococcus sp.
  - Peptostreptococcus sp.
  - Prevotella
  - Veillonella
  - Actinomyces

- “Below Diaphragm”
  - Clostridium perfringens, tetani, and difficile
  - Bacteroides fragilis, disastoni, ovatus, thetaiotaomicron
  - Fusobacterium
Common Bacterial Pathogens by Site of Infection

- Certain bacteria have a propensity to commonly cause infection in particular body sites or fluids
- Antibiotic may be chosen before results of the culture are available based on some preliminary information
  - Site of infection and likely causative organism
  - Gram-stain result (does result correlate with potential organism above)

Bacteria by Site of Infection

<table>
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<tr>
<th>Skin / Soft Tissue</th>
<th>GI Tract</th>
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<tr>
<td>Staph. aureus</td>
<td>Enterococcus</td>
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<tr>
<td>Strep. pyogenes</td>
<td>E. coli, Proteus, Klebsiella</td>
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<tr>
<td>Staph. epidermidus</td>
<td>Bacteroides spp.</td>
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<td></td>
<td>Streptococcus spp.</td>
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Antibiotic Overview

- **β-Lactam Characteristics**
  - Same MOA: Inhibit cell wall synthesis
  - Bactericidal (except against Enterococcus sp.); time-dependent killers
  - Short elimination half-life
  - Primarily renally eliminated (except nafcillin, oxacillin, ceftriaxone, cefoperazone)
  - Cross-allergenicity - except aztreonam

ALL β-lactams

- **Mechanism of Action**
  - Interfere with cell wall synthesis by binding to penicillin-binding proteins (PBPs) which are located in bacterial cell walls
  - Inhibition of PBPs leads to inhibition of peptidoglycan synthesis
  - Are bactericidal

ALL β-lactams

- **Mechanisms of Resistance**
  - Production of beta-lactamase enzymes
    - Most important and most common
    - Hydrolyzes beta-lactam ring causing inactivation
  - Alteration in PBPs leading to decreased binding affinity
  - Alteration of outer membrane leading to decreased penetration
Classification and Spectrum of Activity of Cephalosporins

- Divided into 4 major groups called “Generations”
- Are divided into Generations based on
  - antimicrobial activity
  - resistance to beta-lactamase

Carbapenems
Spectrum of Activity

- Most broad spectrum of activity of all antimicrobials
- Have activity against gram-positive and gram-negative aerobes and anaerobes
- Bacteria not covered by carbapenems include MRSA, VRE, coagulase-negative staph, C. difficile, S. maltophilia, Nocardia

Fluoroquinolones

- Novel group of synthetic antibiotics developed in response to growing resistance
- Agents available today are all structural derivatives of nalidixic acid
- The fluorinated quinolones (FQs) represent a major therapeutic advance:
  - Broad spectrum of activity
  - Improved PK properties – excellent bioavailability, tissue penetration, prolonged half-lives
  - Overall safety
- Disadvantages: resistance, expense

Mechanism of Action

- Unique mechanism of action
- Inhibit bacterial topoisomerases which are necessary for DNA synthesis
  - DNA gyrase – removes excess positive supercoiling in the DNA helix
    - Primary target in gram-negative bacteria
  - Topoisomerase IV – essential for separation of interlinked daughter DNA molecules
    - Primary target for many gram-positive bacteria
- FQs display concentration-dependent bactericidal activity

Mechanisms of Resistance

- Altered target sites – chromosomal mutations in genes that code for DNA gyrase or topoisomerase IV
  - most important and most common
- Altered cell wall permeability – decreased porin expression
- Expression of active efflux – transfers FQs out of cell
- Cross-resistance occurs between FQs

The Available FQs

**Older FQs**
- Norfloxacin (Noroxin®) - PO
- Ciprofloxacin (Cipro®) – PO, IV

**Newer FQs**
- Levofloxacin (Levaquin®) – PO, IV
- Gatifloxacin (Tequin®) – PO, IV
- Moxifloxacin (Avelox®) – PO, IV
FQs Spectrum of Activity

**Gram-positive** – older agents with poor activity; newer FQs with enhanced potency
- Methicillin-susceptible *Staphylococcus aureus*
- *Streptococcus pneumoniae* (including PRSP)
- Group and viridans streptococci – limited activity
- *Enterococcus sp.* – limited activity

**Gram-Negative** – all FQs have excellent activity (cipro>lev>gati>moxi)
- *Enterobacteriaceae* – including *E. coli, Klebsiella sp, Enterobacter sp, Proteus sp, Salmonella, Shigella, Serratia marcescens, etc.*
- *H. influenzae, M. catarrhalis, Neisseria sp.*
- *Pseudomonas aeruginosa* – significant resistance has emerged; ciprofloxacin and levofloxacin with best activity

FQs Spectrum of Activity

**Anaerobes** – only trovafloxacin has adequate activity against *Bacteroides sp.*

**Atypical Bacteria** – all FQs have excellent activity against atypical bacteria including:
- *Legionella pneumophila* - DOC
- *Chlamydia sp.*
- *Mycoplasma sp.*
- *Ureaplasma urealyticum*

**Other Bacteria** – *Mycobacterium tuberculosis, Bacillus anthracis*

Aminoglycosides

**Mechanism of Action**
- Multifactorial, but ultimately involves inhibition of protein synthesis
- Irreversibly bind to 30S ribosomes
  - must bind to and diffuse through outer membrane and cytoplasmic membrane and bind to the ribosome
  - disrupt the initiation of protein synthesis, decreases overall protein synthesis, and produces misreading of mRNA
- Are bactericidal

**Mechanism of Resistance**
- Alteration in aminoglycoside uptake
  - decreased penetration of aminoglycoside
- Synthesis of aminoglycoside-modifying enzymes
  - plasmid-mediated; modifies the structure of the aminoglycoside which leads to poor binding to ribosomes
- Alteration in ribosomal binding sites
Aminoglycosides

**Spectrum of Activity**

**Gram-Positive Aerobes**
- most *S. aureus* and coagulase-negative staph
- viridans streptococci
- *Enterococcus* sp.

**Gram-Negative Aerobes** (not streptomycin)
- *E. coli, K. pneumoniae, Proteus* sp.
- *Acinetobacter, Citrobacter, Enterobacter* sp.
- *Morganella, Providencia, Serratia, Salmonella, Shigella*
- *Pseudomonas aeruginosa* (amik < tobra < gent)

**Mycobacteria**
- *tuberculosis* - streptomycin
- *atypical* - streptomycin or amikacin

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**Adverse Effects**

**Nephrotoxicity**
- nonoliguric azotemia due to proximal tubule damage; increase in BUN and serum Cr; reversible if caught early
- risk factors: prolonged high troughs, long duration of therapy (> 2 weeks), underlying renal dysfunction, elderly, other nephrotoxins

**Ototoxicity**
- 8th cranial nerve damage - vestibular and auditory toxicity; irreversible
- vestibular: dizziness, vertigo, ataxia – S, G, T
- auditory: tinnitus, decreased hearing – A, N, G
- risk factors: same as for nephrotoxicity

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**Vancomycin**

- Complex tricyclic glycopeptide produced by *Nocardia orientalis*, MW = 1500 Da
- Commercially-available since 1956
- Current product has been extensively purified - decreased adverse effects
- Clinical use decreased with introduction of antistaphylococcal penicillins
- Today, use increasing due to emergence of resistant bacteria (MRSA)

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**Mechanism of Action**

- Inhibits bacterial cell wall synthesis at a site different than beta-lactams
- Inhibits synthesis and assembly of the second stage of peptidoglycan polymers
- Binds firmly to D-alanyl-D-alanine portion of cell wall precursors
- Bactericidal (except for *Enterococcus*)

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**Mechanism of Resistance**

- Prolonged or indiscriminate use may lead to the emergence of resistant bacteria
- Resistance due to modification of D-alanyl-D-alanine binding site of peptidoglycan
  - terminal D-alanine replaced by D-lactate
  - loss of binding and antibacterial activity
- 3 phenotypes - vanA, vanB, vanC

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**Spectrum of Activity**

**Gram-positive bacteria**
- Methicillin-Susceptible AND Methicillin-Resistant *S. aureus* and coagulase-negative staphylococci
- *Streptococcus pneumoniae* (including PRSP), viridans streptococci, Group streptococci
- *Enterococcus* sp.
- *Corynebacterium, Bacillus, Listeria, Actinomyces*
- *Clostridium* sp. (including *C. difficile*), Peptococcus, Peptostreptococcus

**No activity against gram-negative aerobes or anaerobes**
Vancomycin

Clinical Uses

- Infections due to methicillin-resistant staph including bacteremia, empyema, endocarditis, peritonitis, pneumonia, skin and soft tissue infections, osteomyelitis
- Serious gram-positive infections in β-lactam allergic patients
- Infections caused by multidrug resistant bacteria
- Endocarditis or surgical prophylaxis in select cases
- Oral vancomycin for refractory *C. difficile* colitis

Vancomycin

Adverse Effects

- Nephrotoxicity and Ototoxicity
  - rare with monotherapy, more common when administered with other nephro- or ototoxins
  - risk factors include renal impairment, prolonged therapy, high doses, high serum concentrations, other toxic meds
- Dermatologic - rash
- Hematologic - neutropenia and thrombocytopenia with prolonged therapy
- Thrombophlebitis

Oxazolidinones

- Linezolid (Zyvox®) is the first available agent which received FDA approval in April 2000; available PO and IV
- Developed in response to need for agents with activity against resistant gram-positives (MRSA, GISA, VRE)
- Linezolid is a semisynthetic oxazolidinone which is a structural derivative of earlier agents in this class

Linezolid

Mechanism of Action

- Binds to the 50S ribosomal subunit near to surface interface of 30S subunit – causes inhibition of 70S initiation complex which inhibits protein synthesis
- Bacteriostatic (cidal against some bacteria)

Mechanism of Resistance

- Alterations in ribosomal binding sites (RARE)
- Cross-resistance with other protein synthesis inhibitors is unlikely

Linezolid

Spectrum of Activity

**Gram-Positive Bacteria**
- Methicillin-Susceptible, Methicillin-Resistant AND Vancomycin-Resistant *Staph aureus* and coagulase-negative staphylococci
- *Streptococcus pneumoniae* (including PRSP), viridans streptococcus, Group streptococcus
- *Enterococcus faecium* AND *faecalis* (including VRE)
- *Bacillus, Listeria, Clostridium sp.* (except *C. difficile*, Peptostreptococcus, *P. acnes*

**Gram-Negative Aerobes – relatively inactive**

**Atypical Bacteria**
- *Mycoplasma, Chlamydia, Legionella*

Clindamycin

Clindamycin is a semisynthetic derivative of lincomycin which was isolated from *Streptomyces lincolnesis* in 1962; clinda is absorbed better with a broader spectrum
**Clindamycin**

**Mechanism of Action**
- Inhibits protein synthesis by binding exclusively to the 50S ribosomal subunit
  - Binds in close proximity to macrolides – competitive inhibition
- Clindamycin typically displays bacteriostatic activity, but may be bactericidal when present at high concentrations against very susceptible organisms

**Mechanisms of Resistance**
- Altered target sites – encoded by the *erm* gene which alters the clindamycin binding site on the ribosome; confers high level resistance to all macrolides, clindamycin and Synercid
- Active efflux – *mef* gene encodes for an efflux pump which pumps the macrolide out of the cell but NOT clindamycin; confers low level resistance to macrolides, but clindamycin still active

**Spectrum of Activity**

**Gram-Positive Aerobes**
- Methicillin-susceptible *Staphylococcus aureus* (MSSA only)
- *Streptococcus pneumoniae* (only PSSP) – resistance is developing
- Group and viridans streptococci

**Anaerobes – activity against Above the Diaphragm Anaerobes (ADA)**
- *Peptostreptococcus*
- *Actinomyces*
- *Propionibacterium*
- *Clostridium sp.* (not *C. difficile*)

**Other Bacteria**
- *Pneumocystis carinii*, *Toxoplasmosis gondii*, *Malaria*

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**Metronidazole**

**Mechanism of Action**
- Ultimately inhibits DNA synthesis
  - Prodrug which is activated by a reductive process
  - Selective toxicity against anaerobic and microaerophilic bacteria due to the presence of ferredoxins within these bacteria
  - Ferredoxins donate electrons to form highly reactive nitro anion which damage bacterial DNA and cause cell death
- Metronidazole displays concentration-dependent bactericidal activity
Metronidazole
Spectrum of Activity

Anaerobic Bacteria (BDA)
- Bacteroides sp. (ALL)
- Fusobacterium
- Prevotella sp.
- Clostridium sp. (ALL)
- Helicobacter pylori

Anaerobic Protozoa
- Trichomonas vaginalis
- Entamoeba histolytica
- Giardia lamblia
- Gardnerella vaginalis

Definitions
- Infection
- SIRS
- Sepsis
- Severe sepsis

Infection
- a pathologic process caused by the invasion of normally sterile tissue or fluid or body cavity by pathogenic or potentially pathogenic microorganisms

SIRS
- SIRS is considered to be present when patients have more than one of the following clinical findings:
  - Body Temperature
    - >38°C or <36°C
  - Heart rate
    - >90 / min
  - Hyperventilation
    - RR >20 / min or Paco2 <32 mm Hg
  - Leukocytosis
    - WBC >12,000 cells/µL or <4,000/µL

Sepsis
- Sepsis
- Infection and SIRS
- Severe Sepsis
  - sepsis associated with organ dysfunction, hypoperfusion, or hypotension
- Septic Shock
  - sepsis with arterial hypotension, despite adequate fluid resuscitation

Community-Acquired Infections
- SKIN AND SOFT TISSUE INFECTIONS
- BREAST ABSCESSES
- PERIRECTAL ABSCESSES
- GAS GANGRENE
- TETANUS
- HAND INFECTIONS
- FOOT INFECTIONS
- BILIARY TRACT INFECTIONS
- ACUTE PERITONITIS
### Skin and Soft Tissue Infection
- Presents with spreading Cellulitis. Blanching erythema caused by *streptococcus* group A.
- *Staphylococcus* causes Pus.
- Necrotizing streptococcal gangrene rare and manifested by nonblanching erythema. Needs extensive surgical debridement.
- Staph respond to Cloxacillin and if MRSA need vancomycin. Need sterile Isolation vs. reversed Isolation.

### Breast Abscess
- Staphylococcal soft tissue infection.
- Postpartum with Galactoceles
- Pain, swelling, redness and mass
- Aspiration with needle for Diagnosis
- Incision and Drainage is the Treatment
- Antibiotics alone are not enough

### Perirectal Abscess
- Crypts of anorectal canal that suppurate
- Tender masses
- Drained under GA
- Broad-Spectrum Antibiotics to prevent bacteremia but not enough
- Occasionally fecal diversion needed if advanced

### Gas Gangrene
- Clostridial soft tissue include cellulitis and myonecrosis. *Clostridium perfringens*
- Contaminated objects: nail puncture,
- Brown watery discharge from wound and marked tenderness
- Palpable crepitance. X-rays show GAS
- Tetanus immunization, and adequate surgical debridement prevents gangrene. Immediate radical surgical Debridement. Penicillin, flagyl and clindamycin. Hyperbaric oxygen??

### Tetanus
- Lockjaw caused by enterotoxin secreted by *clostridium tetani*. 2 days to several weeks incubation then prodromal symptom complex
- Jaw stiffness, muscular contractions, tonic spasms and respiratory arrest
- Key: debridement and cleansing of devitalized tissue with immunization program
- Tetanus-prone wounds need toxoid; immune globulin needed when no recent immunization and Penicillin

### Hand Infections
- Paronychia: staph.infection of proximal fingernail at nail border. Simple drainage
- Felons: deep infection of pulp space of terminal phalynx. Penetrating injuries. drainage
- Subungal abscess, deep paronychia
- Neglected infections lead to Tenosynovitis.
- Deep-space compartments infection: Thenar, Midpalmar, and Hypothenar. All need I&D, then ABX
- Human bites: polymicrobial. Irrigation,debridement, elevation and systemic antibiotics. No closure. Animal bites: *pasturella*
Foot Infections
- Direct Trauma or mechanical / metabolic derangements in Diabetes (neuropathy)
- Cleansing best to prevent it
- Established infection: FB or osteomyelitis. X-rays and bone scans. Debridement and ABX
- Diabetes: neuropathy, bone deformity, and vascular compromise. Cultures, ABX, Debridement and Drainage. External support.

Biliary Tract Infection
- Obstruction of biliary tree. Cystic and CBD
- Klebsiella, E.coli and Enterococcus
- Surgical intervention for drainage
- Acute cholecystitis: obstruction cystic duct, bacteria entrapped, empyema and sepsis. Undrained results in gangrene and perforation. Early surgery
- Ascending cholangitis: fever, leukocytosis and jaundice. HD instability. Surgical intervention. T-tube or sphincterotomy

Acute Peritonitis
- Perforation of hollow viscus. Primary rare
- Pain acute, fever and leukocytosis. Tenderness with rebound and rigidity.
- Upright films: air under diaphragm
- Perforated PUD might have previous hx. Peritonitis can be purely chemical initially. Repair + or – definitive operation
- Perforated appendix: Symptoms. Abx. Appendectomy and Drainage if abscess

Acute Peritonitis
- Colonic perforation: Cancer or Diverticulitis. Virulent because of colonic microflora high density. Systemically toxic.
- Volume resuscitation, ABX, and Surgery. Manage perforation and drain pus. Left Colon needs diversion
- Other sources might need a laparotomy to reach a specific diagnosis

Hospital-Acquired Infections
- Surgical Site Infections
- Pulmonary Infections
- Urinary Tract infections
- Foreign body associated Infections
- Fungal Infections
- Multiple Organ Failure

Hospital-Acquired Infections
- Postoperative fever: pyrogens, interleukin-1
- Neutrophilia, hypoferremia, hypozincemia and increase C-reactive protein
- Identify pathogen-macrophage interaction before starting empiric antibiotics
- Primary focus of surgical infection must be identified and disrupted before administration of systemic antibiotics
Pulmonary Infection

- Non-ventilator associated pneumonia from atelectasis.
- Poor tidal volumes due to anesthesia, analgesia and incisions.
- Ambulation, cough, deep breathing and nasotracheal suctioning. Spirometers.
- No need for laboratory or radiographic studies initially
- If fever persists CXR can show infiltrates, ABX

Pulmonary Infection

- Postoperative Pneumonitis, can be Ventilator associated. VAP
- Critically ill patients are vulnerable
- ET tube injures mucosa, promotes Bac. Proliferation
- Ventilator showers pulmonary tissues with multiresistant hospital-acquired flora. Weaning
- Pseudomonas, Serratia predominate. Cx and ABX. Bronchoscopy for BAL. Suctioning

Pulmonary Infection

- Aspiration Pneumonia risk postoperatively
- Gastric distention and altered mental status.
- Decompression reduces probabilities
- Bronchoscopy is diagnostic and helpful
- Systemic oxygenation
- Antibiotics withheld until clinical and culture evidence identifies an organism

Urinary Tract Infection

- Due to indwelling Foley catheter
- Prevention: Aseptic placement, firm fixation, closed drainage system, daily care, removal soon.
- Quantitative diagnosis: 100,000 org/mL. Still look for other reasons of fever, bacteriuria does not indicate sepsis
- Pseudomonas and Serratia. Enterococci and candida. Sensitivities needed

Colonization vs Contamination — Definitions

- Colonization
  - Bacteria present in a wound with no signs or symptoms of systemic inflammation
  - Usually less than $10^5$ cfu/mL
- Contamination
  - Transient exposure of a wound to bacteria
  - Varying concentrations of bacteria possible
  - Time of exposure suggested to be < 6 hours
- SSI prophylaxis best strategy
**SSI – Definitions**

- **Infection**
- Systemic and local signs of inflammation
- Bacterial counts \( \geq 10^5 \text{ cfu/mL} \)
- Purulent versus nonpurulent
- LOS effect
- Economic effect
- Surgical wound infection is SSI

**Deep Incisional SSI**

Infection occurs within 30 days after the operation if no implant is left in place or within 1 year if implant is in place and the infection appears to be related to the operation and the infection involves the deep soft tissue (e.g., fascia and muscle layers).

**Superficial Incisional SSI**

Infection occurs within 30 days after the operation and involves only skin or subcutaneous tissue of the incision.

**Organ/Space SSI**

Infection occurs within 30 days after the operation if no implant is left in place or within 1 year if implant is in place and the infection appears to be related to the operation and the infection involves any part of the anatomy, other than the incision, which was opened or manipulated during the operation.

**SSI – Risk Factors**

**Operation Factors**

- Duration of surgical scrub
- Maintain body temp
- Skin antisepsis
- Preoperative shaving
- Duration of operation
- Antimicrobial prophylaxis
- Operating room ventilation
- Inadequate sterilization of instruments
- Foreign material at surgical site
- Surgical drains
- Surgical technique
  - Poor hemostasis
  - Failure to obliterate dead space
  - Tissue trauma

**Patient Characteristics**

- Age
- Diabetes
- HbA1c and SSI
- Glucose > 200 mg/dL postoperative period (>48 hours)
- Nicotine use: delays primary wound healing
- Steroid use: controversial
- Malnutrition: no epidemiological association
- Obesity: 20% over ideal body weight
- Prolonged preoperative stay: surrogate of the severity of illness and comorbid conditions
- Preoperative nares colonization with *Staphylococcus aureus*: significant association
- Perioperative transfusion: controversial
- Coexistent infections at a remote body site
- Altered immune response
### Class 1: Clean wounds
- Atraumatic wound
- No inflammation
- No break in technique
- No entry into biliary, respiratory, GU or GI tracts
- Hernioraphy
- Skin Lesion
- Thyroidectomy
- Infection Rate 1-4%

### Class 1d: Clean with prosthetic
- Same as Class 1
- Prosthetic material implanted
- Vascular surgery with graft
- Cardiac valve replacement
- Infection Rate 1-4%

### Class 2: Clean contaminated
- Atraumatic wound
- No inflammation
- Minor break in technique
- Entry into biliary, respiratory, GI or GU tracts with minimal spillage
- Appendectomy without perforation
- Elective colectomy
- Infection rate 3-6%

### Class 3: Contaminated
- Traumatic wound with delay or contamination
- Inflammation
- Major break in technique
- Gross spillage from biliary, GU, GI or respiratory tracts
- Drainage of abdominal abscess
- Colectomy for colonic perforation
- Infection rate 4-20%

### SSI – Wound Classification
- Class 1 = Clean
- Class 2 = Clean contaminated
- Class 3 = Contaminated
- Class 4 = Dirty infected

### Opportunity to Prevent SSI
- An estimated 40%–60% of SSIs are preventable
- Overuse, underuse, improper timing, and misuse of antibiotics occurs in 25%–50% of operations

Principles of Antibiotic Prophylaxis

- Preop administration, serum levels adequate throughout procedure with a drug active against expected microorganisms.

High Serum Levels
1. Preop timing
2. IV route
3. Highest dose of drug

During Procedure
1. Long half-life
2. Long procedure—redose
3. Large blood loss—redose

Duration
1. None after wound closed
2. 24 hours maximum

Wound Infections
- Tenderness, redness, heat, and induration
- Pus discharge
- Absence of healing ridge in wound
- Open the wound
- Pus evacuated, fibrin debrided, SCT cleaned
- Antibiotics are not an alternative to drainage

Endogenous organisms in the GI tract
- Oropharynx: $10^{11}$ CFU / ml
- Stomach: $10^2 - 10^3$ CFU / ml
- Small Intestine: $10^3 - 10^6$ CFU / ml at TI
- Colon: $10^{11}$ CFU / ml

Common Pathogens
- Gram positive
  - Staphylococcus, Enterococcus, Streptococci
- Gram negative
  - Enterobacteriaceae (E. Coli, Klebsiella, Serratia, Enterobacter), Psuedomonas
- Anaerobes
  - Bacteroides, Fusibacterium, Peptostreptococci

Surgical Site Infection (SSI)

Case 1
- 55 year old female
  - Diabetes Type 2, Obese
  - For elective Right Hemicolecotomy
- Class of Wound
- Expected Pathogens
- Antibiotic Regimens
Case 2
- 32 year old female for an elective resection of a breast lump
- No significant past medical history
- Class of Wound
- Expected Pathogens
- Antibiotic Regimens

Case 3
- 85 year old male with perforated diverticulum
- PMHx emphysema
- Class of Wound
- Expected Pathogens
- Antibiotic Regimens

Intraabdominal Infection
- Most are Abscesses
- Elective Gastrointestinal or Biliary Surgery. Dehiscence of anastomosis. Tenderness, pain, fever, leukocytosis, and toxic septic state
- Contrast studies and CT for Diagnosis
- Initial laparotomy for infection or penetrating Trauma, have bacterial contamination and can develop abscess

Intraabdominal Infection
- Difficult to diagnose: painful incision
- Localized tenderness: 30%
- Palpable masses: 10%
- Roentgenograms: 20% useful
- Gastrograffin studies show filling defects, or leaks
- Fluoroscopic guidance, contrast through drains can show collections
- Ultrasound: inexpensive, bedside, non-invasive, but limitations after surgery.

Intraabdominal Infection
- CT: >90% accuracy in Diagnosis
- Fast and most useful
- Water-soluble contrast oral &/or IV to help distinguish abscesses from GI, vascular or urinary structures.
- Limitations: adynamic ileus, ascites
- Radionuclide scanning after injection of indium-111-labeled leukocytes. Total body scan 1 day after injection

Intraabdominal Infection
- Drainage: primary treatment of abscess
- Localized drainage under CT guidance, using percutaneous catheter
- Septic patients might need reexploration
- Polymicrobial: E.coli, B.fragilis. Complex synergistic relation
- ABX are only adjunct to drainage, diversion, exteriorization or debridement of infected tissue
Pleural Empyema
- After Thoracotomy or Chest tube placement
- Association with a pneumonic process
- Tracheal or Esophageal resections
- Effusion on x-rays. Loculated may be posterior in supine patients
- Ultrasound or CT. Needle thoracentesis for Diagnosis. *Staphylococcus*.
- Tube drainage, rib resection and thoracoplasty.

Foreign Body-Associated Infection
- IV peripheral, Swan-Ganz, Pacemakers, Arterial lines and Central lines are portals of entry to intravascular compartment
- Bacteria migrate from skin to IV compartment, then Bacteremia. Intimal injury and localized clot provide growth medium for bacteria.
- Placed under sterile techniques and changed after 72 hrs.
- Suspect it with positive blood cultures, especially staph. Culture catheter tip.

Foreign Body-Associated Infection
- Treatment consists of removal of FB
- Antibiotics sometimes 14 days (S.aureus) to prevent bacterial endocarditis
- Implanted vascular grafts and orthopedics joints infections are rare; but if it happens removal of the device is mandatory.
- May require alternate prosthetic implants. complex clinical problems. Antibiotic-impregnated beads

Fungal Infections
- Antibiotics wide use is the cause this opportunistic pathogens
- Immunosuppressed, chemotherapy, older and chronic debility are hosts
- Candida are the most common
- Treatment: debridement, Amphotericin B for invasive infections. Fluconazole is less toxic and less efficacious.

Pseudomembranous Colitis
- *Clostridium Difficile* after extensive use of Cephalosporins and Ampicillin
- Diarrhea, Pain, WBC, Pseudomembranes in Colon
- Enterotoxin
- D/C ABX, Oral Vancomycin or Flagyl

Multiple-Organ Failure . MOF
- Proinflammatory products are extensive, systemic exposure occurs and septic state ensues. SIRS.
- Increase in cardiac output, reduction in PVR, hypermetabolism, and lactic acidemia.
- Left untreated, causes dysfunction of metabolic and vascular processes in vital organ systems, resulting in death
- Multiple Organ System Failure (MOSF), in SICU. Treatment entails support of organs